A polyvalent dissipation potential with interpretable viscous material parameters

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In this paper, we present a novel dissipation potential that details the short-time (stiffening) component of viscoelastic response within the constitutive framework set forth by [Pioletti, D. P. and Rakotomanana, L. R., 2000. Non-linear viscoelastic laws for soft biological tissues. European Journal of Mechanics, A/Solids 19, 749-778] for both short and long-time memory effects in finite deformations. The dissipation potential originally used within this constitutive framework introduced one viscous material parameter, and can be assimilated to an extension of Newton linear viscoelasticity. However, different nonlinear stiffening responses may be found in biological soft tissues depending on their composition and microstructural organization. We therefore propose a novel dissipation potential capable in predicting various nonlinear stiffening responses with just four descriptive viscous material parameters whose introduction greatly simplifies the task in contrasting different strain-rate sensitive materials. The hypothesis of asymptotic behavior in the stress strain-rate space provides the basis to both the introduction of interpretable material parameters and the design of a robust material identification algorithm. Under the hypothesis that viscous effects are essentially due to deviatoric contribution, we propose an implementation strategy based on the multiplicative decomposition of the deformation gradient into a volume-changing and a volume-preserving part. This viscoelastic law can accurately predict the stiffening response for both biological soft tissue and synthetic materials in finite unilateral deformation and rates of deformation.

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